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The effect of 12-week pilates exercises on depression and balance associated with falling in the elderly

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Abstract

This study investigated the efficiency of 12-week Pilates exercises on depression and balance associated with falling in the elderly. Before training, the thirty female elderly (in experimental and control groups) were given a Geriatric Depression Scale to assess their depression and functional reach and timed-up-and-go tests to evaluate the balance. Then, the experimental group participated in Pilates exercises and had a test afterwards. Results of Covariance showed the experimental groups experienced a decrease in depression (19.801%), time for functional reach test (16.703%), and timed-up-and-go tests (7.263%). Actually, Pilates exercises decreased depression and improved the balance related to falling in participants.

Key words: Pilates exercises; elderly; depression; falling

1. Introduction

The population of the elderly is increasing due to the decrease in births, improvements in health and the increased life expectancy (Akbari Kamrani, et al. 2006). In 2006, people above 60 years were approximately 687 million and 923 thousand in the entire world and it is predicted that this figure increases to 1 billion, 968 million and 153 thousand people in 2050 (Habibi, et al. 2008). Iran is not exempted from this demographic phenomenon, in that during five censuses from 1956 to 1996, the population of elderly increased from 3 percent to 6.6 percent and in other words it has grown about 100 per cent (Foroughan, 2002). Statistics center has announced the population of elderly to be 512104 in 2006 which consists 7.2% of the whole population and it is predicted that the population of elderlies reach

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above 25 million in 2050 (Statistical Center of Iran, 2006; Shahbazi, et al. 2008). This will double the requirement to address the issue of aging in developing countries.

Though reaching the elderly age is one of the main human developments, but unfortunately most people who become old suffer from a number of illnesses and serious health problems (Spar & La Rue, 2002). Among these, falling or stumbling has been introduced as one of the widespread problems among elderlies which affect all dimensions of their health (Akbari Kamrani, et al. 2006). A review of research indicates that this loss of balance and falling, is the sixth leading cause of death in the elderly population which accompanies a number of illnesses and disabilities; so that most elderlies who fall are hospitalized and their number is 10 times more than other people (Mojani, 2007). The estimated cost of 3 billion dollars with an average of 11.6 days being hospitalized for the fracture of each individual, loss of self-confidence and physical fitness and joint restrictions, muscle weakness, limitation in daily activities, lack of balance in walking, social isolation, increased reliance on others and fear of falling are among the consequences of falling in this age (Lgters, 2002). Despite the fact that economic costs resulting from falls are increasing, the loss of mobility in the elderly that will lead to the loss of their independence and autonomy is the biggest loss for the remaining years of life (Krotish, 2008). Aging and gradual loss of function of various body systems provide many changes in health-related factors and conditions for the falling of elderlies (Foroughan, 2010). Previous studies have shown that that factors underlying for the falling of elderlies include a history of failure, lower limb muscle weakness, balance and an abnormal gait, decreased muscle strength, older age, being female and psychological factors (depression) (Sai, et al. 2010). Knowing the importance and the role of falling, we discuss the balance and psychological factors associated with falling.

Changes that occur during aging are partly the result of gradual loss of function of different systems of the body (Foroughan, 2010). After the age of 30, most organ systems annually lose one percent of their functioning (Sadavory, et al. 2005). Some physical factors, such as balance in static and dynamic situations that play a significant role in elderly's health (Wojtek, et al. 2009), are also prone to these changes. Reduction in skills of balance and impairment in gait patterns are of key factors of falling and other motor problems of the elderly. Balance is the basis of independent living and dynamicity (Shumway-cook & Woollacott, 2007) in the way that two-thirds of the elderlies who fall have a balance disorder Woollacott & Shumway-Cook, 2002). So, there is a correlation between loss of balance and falling in the elderly. Loss of balance leads to an increase in injuries and falls and will result in too much healthcare costs for the individual and the society. Therefore, the necessity of appropriate intervention strategies to prevent negative effects is felt.

On the other hand, changes in the functioning of body systems will reduce social participation and physical activity of elderlies and this fact result in some psychological problems including depression in the elderly. According to World Health Organization study (1992) on depression in old age, 15% of men and women over 65 who live in the community are suffering from depression (Tajvar, 2003). About 2% of who are progressing towards severe depression (Karel, et al. 2002). In Iran, 35 to 45 percent of mental diseases are allocated to the depression and unfortunately this trend is increasing (Tajvar, 2003). Therefore, depression is one of the most common psychiatric disorders of the elderly and one of the most common risk factors for suicide in elderly (Maghsoodnia, 2006). On the other hand, depression is not the natural consequence of aging and in the healthy independent elderly, the prevalence of severe depression, is less than the general population (Valenstein, et al. 2004). In addition, the depression in the elderly as in younger people is because of social, psychological and biological factors (Maghsoodnia, 2006). Therefore, special attention should be given to this factor since depression paves the ground for a decrease in daily activities and isolation of this group of community. Untreated depression in the elderly significantly reduces quality of his/her or the family's life (Unutzer, 2007), and might result in the elderly's falling (Babayigit Irez, 2009), therefore, we need appropriate interventional approach to prevent the negative effects of depression and ultimately, to prevent falling.

In recent years, prevention of falls in older people has been increasingly raised as a public health issue (U. S. Department of Health and Human Services, Office of Disease Prevention and Health Promotion, 2010). Among these, the use of sport and physical activity has been accepted as an effective agent in preventing falls in elderly people (Iwamoto, et al. 2009). Previous attempts have pointed to the positive effects of exercising on decreasing depression and improving the balance which is associated with health and falling in the elderly (Gardner, et al. 2000; Deslandes, et al. 2010; Correa, et al. 2009; Bastone & Filho, 2004). A meta-analysis study of Gardner et al (2000) showed that exercise is effective for reducing the risk of falls in elderly and consequently decreases the incidence of injuries resulting from falls and reduces health care costs (Gardner, et al. 2000). Furthermore, studies have shown that various types of exercising have important effects on decreasing the depression of healthy elderlies and those with different levels of depression (Deslandes, et al. 2010; Correa, et al. 2009; Bastone & Filho, 2004). For example, in Correa et al.'s study, that compares the quality of life and depression level among active and sedentary elderly women, results pointed to the satisfaction of the exercise intervention programs (dancing, aerobics, meditation, and yoga) to help the quality of life and depression level of active elderly women in comparison to sedentary elderly women (Correa, et al. 2009). On the other hand, improvement in physical abilities, including balance (Cromwell, et al. 2007), reduces the risk of falls and injuries in the elderly. Based on Iwamoto et al.'s report, elderly's participation in a five-month period of balance training program is beneficial for muscle strength and walking ability of elderly (Iwamoto, et al. 2009). Considering the positive effects of exercise and physical activity on depression and balance associated with falls in the elderly, we introduce a new form of mental-physical exercise named Pilates which focuses on motion control, body position and breathing (Sorosky, et al. 2007). Pilates consists of a physical exercise that uses resources such as gravity and the resistance of springs, either to resist or assist movement execution (Gagnon, 2005). The exercise has been known by doctors as a unique method of physical fitness, in which a combination of strengthening, stretching and breathing muscles are used to develop the trunk muscles and restore muscle balance (Smith & Smith, 2005; Latey, 2001; Kloubec, 2010; Cozen, 2000; Bernardo, 2007). Unlike traditional resistance exercise in which muscles are exercised separately, Pilates exercise with a holistic approach needs to enable the coordination of several muscle groups at one time (Pilates, 2001). Although recent studies have reported that Pilates exercise is appropriate for all ages, all body types and different physical fitness (Johnson, et al. 2007; Caldwell, et al. 2009), there is a need for further attempts which clearly illustrate the benefits of Pilates exercise on improving physical functioning and other health factors among elderly (Babayigit Irez, et al. 2011). For example, in a comprehensive review of literature, Smith & Smith, (2005) suggested that Pilates exercises may reduce the risk of falling by improving the balance, muscle strength and coordination (Smith & Smith, 2005). Most experimental research on the effects of Pilates has been limited to studying youth and adults (Johnson, et al. 2007; Caldwell, et al. 2009; Segal, et al. 2004; Sekendiz, et al. 2007). In addition, few studies have been conducted on the effect of Pilates exercises on elderlies in abroad (Babayigit Irez, et al. 2011; Smith & Smith, 2005; Kaesler, et al. 2007; Hall, et al. 1999; Siqueira Rodrigues, et al. 2010). So, there is a need for empirical research on the elderly.

The significant point in this study is applying the most important fall predictor tests in the elderlies (Sai, et al. 2010; Gai, et al. 2010). Among previous attempts which have investigated the effect of Pilates exercises on elderly's balance and depression, few have used one of the tests which this study applies (Kaesler, et al. 2007). According to our knowledge, few studies have investigated the effect of Pilates exercise on the falling of elderlies (Babayigit Irez, et al. 2011), none of which have used these tests. Considering the scarcity of studies on the effects of Pilates on the elderly and the innovation of using these tests in the current attempt and considering the fact that there has been no studies on the effect of Pilates exercises on the elderly in Iran, the purpose of this study is to investigate the efficiency of 12-week Pilates exercises on depression and balance associated with falling in the elderly.

2. Methodology

This design of the study is quasi-experimental with pretest-posttest on 30 elderly women aged 62-80. Participants were sampled randomly from the population of elderly women who visited Comprehensive Geriatric Rehabilitation Center of Chaharmahal and Bakhtiari in 2011. They were divided into two groups of control and experimental. The inclusion criteria were: 1- healthy elderly women aged over 60, 2- the score of 18 on the abbreviated mental test examination, 3- not using the cane and the ability to walk independently, 4- without acute pulmonary heart disease, brain injury, Parkinson's disease, 5- without significant orthopedic disabilities or chronic illness. After collecting demographic data (age, height, weight, and education level) and getting the consent of the participants, they were divided into experimental and control groups.

Prior to initiating the exercise program, the short form of Geriatric Depression Scale was given to all participants to evaluate the psychological factors. The short form (15 items) was extracted out of the questionnaire with 30 questions (Sheikh, et al. 1986), with the coefficient alpha of 0.9. In similar attempts in China, Malaysia and English, the coefficient alpha ranged from 0.7 to 0.9 (Malakooti, et al. 2006). The test-retest reliability ranged from 0.7 to 0.84 and its content reliability was 0.82 (Almeida & Almeida, 1999; De Craen, et al. 2003). In Malakooti et al (2006), study, which was on the normalization of the of 15-question version of Geriatric Depression Scale (GDS), it was found that the 11-question form is extracted from the 15-question form eliminating questions 9, 2, 13 and 10 and it has similar Alpha coefficient (0.92) and Correlation Coefficient (0.58) ($P < 0.001$). It has higher correlation with depression symptoms and its validity and reliability is higher than the 15-question form (Malakooti, et al 2006).

In the current study, functional reach test and timed up and go test were used to assess the balance. Functional reach test, by definition, is the distance that one can reach forward beyond arm's length, while maintaining a fixed base of support in the standing position. Duncan et al. showed that the functional reach test can well assess the balance of elderlies (Shumway-cook & Woollacott, 2007; Bennie, et al 2003; Duncan, et al, 1990). In functional reach test, the tester stands in a predetermined place near a yardstick or tape measure on the wall, at the dominant arm. The subject is asked to stand with the feet a comfortable distance apart, and forward flex the dominant arm to approximately 90 degrees. The subject is asked to reach forward as far as possible without taking a step or touching the wall. The distance between the start and end point is then measured and the difference between the first and the second measurement in centimeters is the obtained score (Mathias, et al, 1990). The test is a good predictive of falls in older adults and its reliability is $r = 0.89$ and its validity is $r = 0.71$ (Gai, et al, 2010).

In 1986, the timed up and go test was designed by Mathias et al (1986) as a quick way to determine the influential balance problems on motor skills of elderlies' daily lives (Mathias, et al, 1990). The test involves three steps of getting up from the chair, walking, turning and returning and the scoring simultaneously happens as these steps are performed (Shumway-cook & Woollacott, 2007). To perform this test, the tester is asked to sit and put his/her hands on a chair of approximately the height of 46 centimeters and to stand up from his seat with the command of "start now" and to walk, turn and return a distance of 3 meters along the straight line at a normal speed and then sit in his/her seat (Paula, et al, 2000). The time starts with the command of "start now" and ends when the tester sits on the seat and she/he sits back (Lange, et al, 2000). The reliability of the test is 0.99 and it predicts the risk of falling (Lange, et al, 2000). Also, this test is the most important test for predicting the future falls of people the history of falling (Sai, et al, 2010).

After gathering pre-tests of all subjects, the experimental group received a Pilates exercise training, 3 sessions of one hour per week for a duration of 12 weeks. Exercises that were used in this study were consistent with the exercise programs that were used in studies abroad (Latey, 2001; Pilates, 2001; Segal, et al, 2004; Kaesler, et al, 2007). The exercises were divided into 2 parts. The first part of training was

performed on the mats (6 weeks) and the second part of exercises was performed using bands (the second 6 weeks). The subjects of the control group did their daily activities in the training period. After performing the exercises, the two groups participated in the post-test to make the efficiency of exercises.

3. Findings

The obtained data went through descriptive statistics such as mean and standard deviation (SD), and Covariance analysis at the significant level of $\alpha = 0.05$ was used for inferential statistics (see Table1).

Table 1. ANCOVA for depression scores and balance in Pilates and control groups

Variable		Pilates		Control		F	α
		Pretest	Posttest	Pretest	Posttest		
Depression	Geriatric Depression Scale(GDS)	7.07 ± 1.907	5.67 ± 1.291	6.53 ± 0.990	7.27 ± 1.710	8.365	0.007*
Balance	functional reach test (FRT) (Centimeter)	18.1940 ± 2.682	21.2333 ± 4.410	18.0573 ± 3.678	18.8453 ± 3.153	4.789	0.037*
	Timed up and go test (TUG) (seconds)	13.0980 ± 2.429	12.1467 ± 2.573	13.3360 ± 2.033	13.7927 ± 1.889	13.21	0.001*

*P≤0.05

As can be seen in Table 1, the obtained F for depression ($F = 8.365$, $P < 0.007$) is significant for depression. Moreover, the F value for functional reach test ($F = 4.789$, $P < 0.037$) and timed up and go test ($F = 13.21$, $P < 0.000$) is significant.

4. Discussion

The current study investigated the effect of a Pilates exercise program on psychological factors and physical factors associated with falls in elderly women. Doing the defined activities during the training program, made a 19.801% decrease in the depression level of the Pilates training group. In addition, the time for functional reach test (16.703%) and the timed up and go test (7.263) decreased significantly on the effect of Pilates exercises. Physical factors that played a major role in the falling of the elderly improved after the training period. After reviewing the literature, it was found that the Pilates exercise improves depression and increase dynamic and static balance (Hassan, et al, 2011). As pointed out before, reduction of the balance in the elderly plays an important role in increasing the probability of falls, therefore, Pilates exercises might reduce falls rate by improving the balance. Previous studies also have shown that Pilates exercise reduces depression and improves balance in older people (Babayigit Irez, et al. 2011; Smith & Smith, 2005; Kaesler, et al. 2007; Hall, et al. 1999; Siqueira Rodrigues, et al. 2010).

Babayigit Irez (2009) determined the effect of 12-week Pilates exercise on women above 65 years for a period of one year. Participants received Pilates exercise training, 3 sessions of one hour per week for duration of 12 weeks. The results of 12-week Pilates exercise revealed its efficiency in preventing falls, increasing muscle strength, dynamic balance, reaction time and reducing depression and improving the quality of life of elderly women over 65 (Babayigit Irez, 2009). In the current study a 12-week course of Pilates exercises have been used and results showed that Pilates exercise is effective in reducing depression and improving dynamic equilibrium of elderlies. The effects of Pilates exercise on reducing depression in the elderly can be attributed to the role of serotonin. Since, imbalance in serotonin levels may affect one so that it leads to depression (Hassan & Amin, 2011). One strategy that can increase

serotonin is exercising (Simon & Young, 2007). Which naturally raises one's consciousness and his/her general spirit and gives more energy and vitality to people to perform routine tasks of life (Rueter & Jacobs, 1996). For example, a 12-week Pilates exercise increased blood serotonin levels and reduced depression in women (Hassan & Amin, 2011).

In addition, Siqueira Rodrigues et al (2010) investigated the effect of Pilates exercise program on 52 elderly women. The experimental group participated in Pilates exercises for two sessions per week for 8 weeks. Results showed a significant improvement in personal independence, static equilibrium and quality of life of elderly people (Siqueira Rodrigues, et al, 2010). In another study, Hall et al (1990) in their study investigated the effect of Pilates exercises on the balance and gait in the elderly. Thirty-one men and women ranging in age from 65 to 81 years participated in the study, and 24 subjects completed the 10-week training program. Pre- and post-training measurements of static and dynamic balance were performed on the Kinesthetic Ability Training (KAT 2000) balance platform and the Berg Balance Scale (BBS) was used as a field measure of balance and gait. . Results indicate that PBT is an effective mode of exercise for improving static or postural balance in elderly adults (Hall, et al, 1990).

Also, Kaesler et al (2007) investigated the effectiveness of a novel Pilates-inspired exercise program specifically designed to improve balance in an upright position in older adults. Participants of the study were eight community-dwelling men and women aged 66–71 years. They undertook the exercise regimen twice weekly for 8 weeks. The pre- and post-subject assessment included postural sway (static and dynamic), the timed get up and go test (TGUGT), sit-to-stand (timed one repetition and repetitions over 30s) and a four stage balance test. Results of the study showed a significant improvement in some components of static and dynamic postural sway as well as the TGUGT following training. Based on their results a balance training program of Pilates-inspired exercises over a short duration may lead to improvements in postural stability Kaesler et al (2007).

In the current attempt, the timed up and go test was used to measure the balance in the elderlies and results showed that a 12-week Pilates program can help to improve balance in older people. Improve balance in Pilates exercises can be examined based on systems theory. According to the theory of systems, control ability in space is due to the simultaneous and complex interactive effect of the musculoskeletal nervous system; which is called the posture control system. This system considers combining the sensory data to determine the body position in space, as well as, musculoskeletal system's ability to apply appropriate force necessary for the posture control to maintain balance, and perform the subsequent motion. In this model the central sensory motor system, by the use of information provided by vision systems, vestibular, and …(including joint position sense and peripheral sense), is informed of body position against center of gravity and as a result provides the appropriate motor response in form of a pre-planned movement patterns. Thus, according to systems theory and the effect of exercise on improving each of these systems (Alizadeh, et al. 2009), it seems logical that Pilates exercises improve balance in elderly. Moreover, the improvement of physical factors (balance) due to the Pilates exercises can be obtained for the improvement of muscle strength and psychological factors of the participants. Since, the loss of muscle strength in lower extremities puts the center near the ankle joint, which in turn impairs the balance and leads to fall. Furthermore, improvement in muscle strength can cause displacement of the ankle joint center and improve balance (Hobeika, 1999). Also, theoretically, psychological factors like fear, depression, anxiety, low self-esteem, withdrawal and isolation can increase the risk of falling among the elderly population by interaction with the physical factors of internal and environmental factors (Kevin, et al. 2003; Whooley, et al. 1999). Studies show that there is a connection between psychological problems (especially depression) and impaired physical performance. This finding suggests that each psychological factor is influential enough on the individual's functioning and can potentially influence his/her physical performance (Pennix, et al. 2000). And as proven exercise training reduces depression (Deslandes, et al. 2010; Correa, et al. 2009;).

Thus, improvement in the balance, in the present study, can be attributed to its positive effects on muscle strength and reduce in depression. The tests used in this study to evaluate the balance were the

most important predictors of falls in the elderly (Sai, et al. 2010; Gai, et al. 2010). And as the results of the study showed, Pilates exercises resulted in positive changes in these variables; so, it can be concluded that the use of Pilates exercises may reduce the falls rate. Another important factor about the tests used in the present study is their novelty; since, among the few studies that have investigated the effects of Pilates on falls in elderly (Babayigit Irez, et al. 2011) none has used the tests used in the current attempt. Finally, since most falls occur in the interaction between multiple risk factors (Gardner, et al. 2001), to prevent and reduce falls methods which include all relevant risk factors must be used. For example, a meta-analysis by Chang et al (2004) on the interventions for the prevention of falls in older adults reported that the prevention of falls program must be multifactorial to be efficient both on the risk of falling and on its degree (Chang, et al 2004). Because Pilates exercises, with its holistic approach, needs activation and coordination of several muscle groups at a time, and is intended to improve flexibility and general health and its emphasis is on strengthening the core (trunk), body positioning, and coordination of breathing with body movements (Segal, et al 2004), it might be able to play the role of a multifactorial intervention on falls in elderly people. Participants in this study were selected from women, so further attempts can use male participants. Also, future research should use larger samples to be of greater generalizability.

5. Conclusion

The results of the study showed that Pilates exercise is efficient in decreasing the depression level and improving the balance of elderly women. Also, findings of the study revealed that Pilates exercises might be a useful tool for helping older people to reduce their falling. Pilates exercise is new in our country and it is not necessary to have space and facilities to practice it. On the other hand, due to the fact that appropriate training programs for elderlies are those in which fast and explosive moves are not used. Furthermore, since the Pilates exercise is low-cost, has low risk and is non-invasive and is such that it is based on very controlled and slow movements, it might be possible to decrease the rate of falling in elderlies and consequently reduce the healthcare costs. And in this way provide a big help to restore the community's senior citizens to better perform activities of daily living. Since, increase in the contribution of elderlies in the social partnership builds a healthy and happy society.

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